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POTATO SCAB

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POTATO SCAB

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Potato scab, caused by an organism known as *Actinomyces scabies* (Thax.) Gussow, has long been a disease of major importance in New Jersey. Although the losses caused by this disease are still considerable, they are not nearly so serious as they were a quarter of a century or more ago The decrease in the destruction caused by this disease may be attributed largely to the application of increased information concerning the effect of various soil factors upon the disease-producing powers of the scab organism, some of which are discussed here.

Description of Disease

Scab is almost entirely a disease of the tuber, but under severe conditions all underground parts of the plant may be affected.

The name "scab" signifies very aptly the type of lesion which this disease makes on the potato. It begins as a minute brown speck, and as the tuber enlarges the lesion also increases in size until single lesions may measure more than ½ inch in diameter. There may be only one spot or a few spots on a potato, or spots may be so numerous that they coalesce, forming a more or less continuous scabbing of the surface. The individual spots may vary from warty or swollen areas to pitted or depressed lesions. Severely affected tubers are rendered almost worthless for commerce, while a mild infection causes a lowering of the grade. Though potatoes may be attacked by this malady at all ages, from the time when they are mere buds until they cease to enlarge, most infections probably occur during the early development of the potato.

Effect of Soil Environmental Factors on the Scab Organism

The organism responsible for the production of potato scab lives for long periods in suitable soils even where potatoes are not grown. In fact, it is known to occur in soils that have never produced a crop of potatoes. Our present knowledge of the subject indicates, however, that it is only under certain soil conditions that the organism thrives and becomes a serious menace to the potato crop. It is known, for instance, that in soils more acid than pH 5 the organism does not do well, whereas it is favored by soils less acid than pH 5.2. On the alkaline side a pH of approximately 9 inhibits scab. The reports of various workers on the effect of soil moisture on the organism

[1] This is a revision of N. J. Agricultural Experiment Station Circular 131.

have been variable, but the majority of investigators have found that dry soil favors development of the organism. Investigations have also shown that well-aerated soils having a temperature between 72 and 86 degrees F. favor the growth of the scab organism.

As the severity of potato scab has been found to be correlated with the amount of inoculum in the soil, it is not surprising that factors which affect the development of the Actinomyces likewise determine how severely the potato crop will be affected with scab. Of the soil factors mentioned; namely, pH, moisture, temperature, and aeration, only the manipulation of the first offers an effective, practical means of scab control. A knowledge of the other soil factors which are important in the growth of Actinomyces helps, however, to explain the presence or absence of the disease.

The most important single scab control measure is undoubtedly the maintaining of the soil reaction (pH) in a range which is unfavorable for the growth of the Actinomyces responsible for the production of potato scab. Such a soil reaction must, however, still be within the range at which the potato plant grows well. By experimentation it has been found that a range in pH of 4.8 to 5.2 meets both these conditions. In soils more alkaline than pH 5.2, scab, if it is troublesome, will continue to be a problem; whereas potatoes grown in soils more acid than pH 4.8 may not produce optimum yields.

Where the soil reaction needs only a slight adjustment to prevent the development of scab, or where scab is not severe, relief may be obtained by the plowing under of green manure together with the use of acid-forming fertilizers. Where a considerable adjustment in soil reaction is required, however, such corrections should be made by broadcasting sulfur on the surface of the soil.

Acid-Forming Fertilizers

In choosing a fertilizer for potato production where scab is somewhat of a problem, the acid or alkaline forming powers of the fertilizer should be seriously considered. Under such circumstances, the use of an alkaline-developing fertilizer such as one in which most or all of the nitrogen is supplied as nitrate of soda, will increase the amount and severity of the scab on the succeeding crop of potatoes. Where an acid-developing fertilizer, such as one in which the nitrogen is present as sulfate of ammonia, is used, however, the scab problem will be decreased.

These facts have been repeatedly demonstrated in experiments conducted in New Jersey over a period of several years. Characteristic of the results of such tests is one in which the fertilizer containing all nitrogen as nitrate of soda produced a crop of which 29.5 per cent of the potatoes were severely scabbed or unsalable, whereas the potatoes produced on plots receiving fertilizers containing sulfate of ammonia as the only source of nitrogen produced

8.1 per cent unsalable scabby potatoes. In this same test a fertilizer in which one-half of the nitrogen was present as sulfate of ammonia and one-half as nitrate of soda, produced a crop of potatoes 10.2 per cent of which were severely scabbed. During a 3-year test, fertilizer in which the nitrogen was present as sulfate and nitrate in combination outyielded the other fertilizer mixtures by 15 or more bushels per acre.

Fertilizers may be made potentially acid by the inclusion of sulfur or sulfate of ammonia, and in some cases the use of such a mixture proves highly successful in controlling scab. Fertilizer mixtures containing sulfur have become very popular in recent years. Where sulfur is applied in this manner, between 50 and 100 pounds per acre is normally used. Greater amounts of sulfur than this, when mixed with the fertilizer and applied in bands, may adversely affect the yields. In some cases, sulfate of ammonia is more effective in preventing scab than is sulfur. It may be that under some circumstances the full value of sulfur is not realized until the critical scab period is past.

Though acid-developing fertilizers are valuable in the control of potato scab, their continued use may lead gradually to such an increase in the soil acidity as to result eventually in decreased yields. To avoid such possibilities, the soil pH should be determined by a competent soil service man at intervals of two or three years. From the results of such analyses, as well as from information on the presence or absence of scab, it should be determined whether an acid-forming or a non acid-forming fertilizer should be used.

Sulfur for Scab Control

In some sections of New Jersey, the common practice is to grow potatoes year after year on the same land. Where scab is severe in such sections it is desirable to adopt control measures that will free the soil from the scab organism in the least possible time. The measures previously outlined cannot meet this condition. In the earlier investigations on methods of eradicating the scab organism from the soil, a number of disinfectants were tried. Of these, sulfur was found to be the only one to give results that were at all satisfactory. In all our experiments, finely ground 200-mesh sulfur has been used. Though the finer spraying and dusting sulfurs are more rapid in their action in the soil, they are too expensive for use in this capacity. Sulfur of itself will not control scab, but its beneficial effects are due to the fact that sulfur, when mixed with the soil, is changed into sulfur-containing acids, which in turn increase the soil acidity and thereby make the soil a less favorable medium for growth of the scab-producing organism.

Experimental comparisons have been made in New Jersey in which untreated check plots were compared with plots receiving 300 and 600 pounds of sulfur per acre. Six experiments of this nature were conducted with the Irish Cobbler variety. The average of the six tests showed a reduction in

the number of unsalable scabby tubers from 48.8 per cent, recorded on the plots receiving no sulfur, to 18.8 per cent on those receiving 300 pounds, and 9.9 per cent on plots treated with 600 pounds of sulfur. At the same time the number of clean potatoes was increased from 22 per cent on the check plots to 54 and 70 per cent on the plots treated with 300 and 600 pounds of sulfur per acre, respectively. The results of these tests are characteristic of a large majority of similar tests.

Rate of Application

In none of the experiments conducted in New Jersey has any treatment given a complete control of scab. Our present knowledge indicates that the efficiency of the sulfur treatment is determined, to a certain extent, by the amount of scab in the crop. In one experiment the number of clean potatoes from a total of 48 plots varied from 0 to 100 per cent. The following year one-half of each of these plots was treated with sulfur, applied at the rate of 450 pounds per acre. The increase in the number of clean potatoes on those plots where the crop ranged from 80 to 100 per cent clean was only 3.6 per cent as a result of the sulfur treatment; on the plots having 40 to 50 per cent clean potatoes, there was an increase of 37.9 per cent in the number of clean tubers; and those plots having 0 to 20 per cent of the crop free from scab showed an increase of 52.2 per cent in the number of clean potatoes. It is apparent from these figures that where there is only a trace of scab the use of sulfur would not be advisable; on the other hand, where there is a heavy infection of scab, the treatment will be found to pay.

In view of the fact that potato yields are markedly reduced in soils that are rendered extremely acid, the use of excessive amounts of sulfur should be avoided. Sulfur in rather large amounts (1000 pounds per acre) has been used, without producing serious injury on some of our heavier soils that have high pH readings. On the other hand, amounts in excess of 300 pounds per acre on light sandy soils or soils with a low pH are likely to be injurious. Because of the many variable factors to be considered in determining how much sulfur should be used per acre, specific recommendations cannot be given here. Such advice should only be acceptable when it is given by a qualified person who has investigated such points as soil pH, texture, and scab record. It is felt by the writers, however, that with few exceptions, sulfur should not be used in excess of 500 pounds per application to the acre on our potato soils where scab has been a problem. If only a small part of the crop has been unsalable, or the soil is light, the application should be reduced to 300 pounds. In many instances scabby potatoes are produced in certain parts of a field while the crop in the remainder of the field yields clean tubers. For such cases only those parts of the field which grow scabby tubers should be treated, rather than the entire field.

How and When to Apply

The results of our experiments indicate that the best time to apply sulfur for the control of scab is in the spring after plowing. In general, the current crop does not benefit from sulfur which is applied just before plowing, either in the spring or in the fall. Nor does the desired protection to the current crop follow the application of sulfur to the soil following the planting of the crop. To ensure best results, sulfur should be broadcast with a lime distributor after the land is plowed and before it is harrowed. In this way the sulfur is uniformly distributed in that part of the soil where the potatoes are to be grown.

Mixing sulfur with the fertilizer is probably the easiest method of application, but where the amount of sulfur to be used exceeds 100 pounds per acre this method of application is not always a satisfactory one. When applied in this manner, a quantity of sulfur sufficient to control scab may cause a considerable reduction in yield and at the same time may not reduce the number of scabby tubers so much as the same quantity of sulfur broadcast. In one experiment consisting of two treatments, adjoining plots were treated with 300 pounds of sulfur per acre. In one treatment the sulfur was broadcast, and in the other it was mixed in and applied with the fertilizer. Not only did the plots on which the sulfur was broadcast outyield, by 27 bushels per acre, the plots receiving the sulfur in the fertilizer, but they produced potatoes that were freer from scab as well. In this test the sulfur in the fertilizer treatment produced a crop that was 24 per cent free from scab, whereas the plots on which the sulfur was broadcast produced potatoes of which 48 per cent were free from scab.

Controlling Scab by Other Treatments

Although sulfur and acid-forming fertilizer salts have given very good results in the control of potato scab, there are certain other materials that have been used with varying degrees of success. Among these are green manures, various mercurials as soil treatments, and seed treatments.

Cover Crop

The plowing under of green manure (cover crop) has long been recognized as a good soil improvement practice. Besides having beneficial physical and chemical effects on soils, such a practice seems to be of some value in controlling potato scab. Though the exact reason for such an effect is not known, the beneficial action is none the less real. Even though the plowing under of green manures aids in the control of scab, this practice of itself will seldom give sufficient protection to correct a severe scab problem. It is a valuable aid, however, when used in conjunction with sulfur or acid-forming fertilizer salts.

Where scab is sufficiently severe to render a large portion of the crop unsalable, it is doubtful whether the plowing under of a green cover crop

or the use of an acid-forming fertilizer will give relief from scab as soon as might be hoped for. Cases have been noted where this practice has resulted in the control of scab, but a period of years was necessary to accomplish the desired results.

Rotation

Probably the best plan to adopt for a field that has grown severely scabbed potatoes, is to give the land over to growing some other crop, including green manures. If the soil is not too alkaline, it is probable that after a few years a clean crop of potatoes could be grown. It is true, however, that the scab organism may remain active in the soil for a long period. There is on record one case where potatoes grown on land that had not been planted in potatoes for 40 years, were very scabby. A proper rotation, however, and the careful selection of fertilizers, should in time result in a clean potato crop.

Mercurials

Compounds of mercury have been used experimentally for scab control for the last decade or more. The results of these tests have been rather confusing because of the fact that in some soils excellent control of scab follows the use of mercurials, whereas in other sections the scab problem may be actually aggravated by their use. Two examples will illustrate how erratic these results have been. In one field calomel, mixed with the fertilizer, was used at the rate of 3 pounds per acre. At harvest time, 89.3 per cent of the potatoes from the calomel-treated rows were free from scab and only 2.2 per cent were unsalable. The check rows in this field produced potatoes of which only 32.8 per cent were free from scab and 37.4 per cent were unsalable. In another field the potatoes harvested from rows treated with calomel at the rate of 5 pounds per acre, applied in the fertilizer, were 97.4 per cent scabby, of which 82 per cent were unsalable. On adjoining untreated rows, 59.2 per cent of the potatoes were scabby, of which 11.5 per cent were unsalable. From these results it can be seen that in some soils calomel provides very effective disease protection, whereas in other soils it may actually increase the severity of scab. This seems to be equally true for all forms of mercury tested.

Because of the difficulty in predicting just how beneficial or how harmful its use will be, mercury cannot be recommended as a soil treatment for general use. Mercurial fungicides should be used very sparingly, if at all, at least until their reaction in the soil in question is ascertained. Perhaps the best procedure would be to try a mercurial on one or two rows across a field, and then, from the results of this small test, decide whether mercury can be used effectively in that soil.

Although this treatment has certain advantages on some soils, it has the disadvantage of being expensive.

Seed Treatment

No discussion regarding the control of potato scab would be complete without a paragraph or two on seed treatments. Even though seed treatments may not be expected to have much effect on the organism in the soil, they might be expected to eliminate the Actinomyces organism on the seed. This is of extreme importance where the seed is to be planted in soils that are free from the scab organism. All the methods and materials outlined below have given satisfactory results in this capacity.

Mercury Dip Treatments

A water preparation of an organic mercurial as recommended by the manufacturer.

or

A suspension of 1 pound yellow oxide of mercury in 60 gallons of water.

The two materials are used as instantaneous dips for seed potatoes before these are cut. Not only are dip treatments of value in preventing the introduction of the scab-producing organism into new soils, but they may also aid in controlling the disease in soils which produce a scabby crop. This is especially true if the seed to be planted is scabby. If the potatoes are to be planted in soils where mercury aggravates the scab problem, mercurials should not be used as a seed treatment. Formaldehyde can be successfully used, however, in such soils.

Formaldehyde Treatment

Formaldehyde, 40 per cent solution	1 pint or 1 pound
Water	30 gallons
Duration of Treatment	½ hour

Suspend the potatoes in a bag in this solution and allow them to remain there for ½ hour. After removal, the potatoes should be spread out in a thin layer so that they may dry as soon as possible. Slow drying will have the same effect as prolonged soaking and may lead to poor germination.

One disadvantage of this treatment is the time involved in making the treatment. The length of the dipping period may be materially shortened by using a heated dipping solution, as follows:

Formaldehyde	2 pints
Water	30 gallons

The potatoes should be dipped for 2 minutes at 118 to 122 degrees F. Then pile them 6 to 8 inches deep and cover with wet sacks for 60 minutes, after which they should be allowed to dry.

If this method is adopted, the solution should not be allowed to get warmer than 122 degrees, since too high a temperature will injure the tubers.